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PROCEEDINGS

OF

The Newport Natural History Society,

1886-7.

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A SKETCH OF THE GEOLOGICAL DEVELOPMENT OF THE PACIFIC SLOPE.

BY GEO. F. BECKER.*

The Pacific slope of the United States is the region the waters of which drain into the Pacific Ocean, or, in other words, the area west of the Rocky Mountains. It embraces not only Washington Territory, Oregon and California, but also Idaho, Nevada, Utah and Arizona, altogether about one-quarter of the area of the Union, excluding Alaska. This region presents marked peculiarities. It comprises most of the deserts of the United States and also some of the most fertile districts. It is of course famous for its mines which have yielded about 2,000 millions of dollars. The Pacific slope is particularly interesting to geologists for many reasons. Its geology is much simpler than that of many regions, while the opportunities afforded for a study of the rocks are unrivalled. This is in part due to the great extent of desert country where but little vegetation and only a scanty soil mask the rocks. The deserts are barren because of the small rainfall, and it is partly owing to this cause that the Colorado River has cut the famous Grand Cañon ; a ravine hundreds of miles in length with almost perpendicular walls in some portions over a mile in height. This is the grandest section through the strata of the earth's surface known in the world. Many great geological facts which have been elucidated in Europe only after prolonged and anxious investigation are illustrated in the simplest and most striking manner in the admirable exposures of the Pacific slope.

This great region is by no means fully explored, but enough has been done by the various government expeditions to furnish material for such a sketch as I propose to offer. I may mention that the first purely geological expedition sent into this region by the general government was led by your townsman, Mr. Clarence King, then scarcely more than a boy in years. Much of the work now being done on the Pacific slope was also planned by him though executed under the directorship of Major Powell.

It is the purpose of the present sketch to indicate the most im-

*Abstract of an address made to the Society, Sept. 3rd, 1886.

portant events in the geological history of the Pacific slope, and to show the relation of these events to the mountain system of the country and to the distribution of ores. It is not needful to insist upon the importance and economic interest of the latter subject. The mountain system will be found to be intimately connected with the distribution of ores, and to possess a further interest from the fact that it determines the climatic conditions of the region.

There are numerous and strong reasons for supposing that the earth was once a fluid mass of melted minerals. Geological history begins when the surface of this mass became solid. This was of course long since, how long it is impossible to tell with accuracy, but the best estimate seems to be that of Sir William Thomson, the famous physicist who, from certain physical data, arrives at the conclusion that the most probable length of the geological period is somewhat over one hundred millions of years. During this time the most various changes have occurred. The water and the carbon of the earth were originally portions of the heated atmosphere. When the atmosphere was sufficiently cooled, seas formed and degradation of the land surfaces began. Every shower carries a portion of earth into the sea and reduces the elevation of the land. This is erosion. There are other causes at work which tend to alter the configuration of the globe. There is a continual tendency of the land and the sea bottoms to rise or sink, and observations justify the conclusion that the land is not really more stable than the surface of the sea. All portions of the land are probably rising or falling or bending at every moment, but of course the movements are indefinitely slower than those of the sea. The causes of these movements are very imperfectly understood, but their existence is unquestionable. It is well known to engineers that even a mass weighing a few tons of a metal like bronze cannot be kept accurately in a given shape, but undergoes a slight deformation in consequence of its own weight. It is easy then to understand that even a mass of steel of the size of the earth may slightly and slowly change its shape.

In the case of the earth, deformation is assisted by deep cracks or partings in the rocks, and when there is relative motion on the two sides of such a crack, we say that a "fault" is produced. When in the course of such a movement, which usually pro-

gresses very slowly, the two rock masses stick for a time and then slip suddenly, the result is an earthquake more or less violent according to the rate of movement and the time it has been interrupted. A slip of only a few inches may produce disasterous results to the inhabitants of a country while modifying the configuration but little. In the course of this sketch I shall have occasion to refer to enormous changes in configuration, some of which have taken place with great violence.

It is impossible to discuss history without some system of chronology. That which is counted by years and days is the simplest but not always the most convenient. We divide our years into months which are periods of different lengths and which receive arbitrary names. In some countries still more irregular divisions are adopted for certain purposes. Thus in England a law is referred to by the year of the reign of the sovereign in which it was passed. In geology we cannot use divisions by years, for we have no means of ascertaining the precise lapse of time between events. Geological history is divided and subdivided into periods marked by the character of the animals and plants which flourished. This division is not absolutely sharp, but no better method has been devised. I shall here employ only the largest divisions of geological time compatible with the discussion in view.

The lowest rocks known to contain organic remains is called the Palaeozoic, but underlying this group is an enormous thickness of rocks, similar to those occurring along the shore of Newport, in which no organic remains have been detected with certainty and which is known as the Archaean. The Archaean rocks have been subjected to violent movements and the action of heated waters, and it is highly probable that any fossils they might have contained would have been obliterated. Modern naturalists are practically a unit in accepting the Darwinian theory of development. If this theory is correct, there must have been life long before the Palaeozoic, for the earliest known fossils, though not representing the most advanced types, are far in advance of the lowest forms of life. The Archaean is very widely spread on the Pacific slope and probably underlies the entire area. This means of course that, at one time or another during

the Archaean, each portion of this region was under water and accumulated sediments. We have now no means of telling how land and water were distributed at any one portion of the Archaean. One important fact is known, viz. that during this period a great fault existed along the western flank of the present Wahsatch range. I shall show that there were probably other similar faults along other of the present ranges.

During the Palaeozoic, Oregon, California, the western half of Idaho and of Nevada and the south western half of Arizona appear to have been for the most part dry land. How much further west than the present Pacific coast this continent extended we have no means of knowing. To the east of this continent lay a great sea in which there gradually accumulated an immense thickness of sediment later turned to rock, chiefly limestone. The Palaeozoic was a period of immense length and in the region under discussion a very quiet period, so that there is scarcely any evidence of disturbance in the deposition of sediment. There is nevertheless evidence of a very important and interesting movement. It appears impossible to avoid the conclusion that as the weight on the sea bottom increased, particularly near the coast in central Nevada, the bottom slowly sank under the weight as if the earth beneath it had possessed a plasticity similar to that of shoemaker's wax. This, though in a vastly smaller degree, is almost certainly true.

For the sake of making a rude comparison between the distribution of land and sea at different epochs, I have represented the conditions during the Palaeozoic by a diagram, Fig. 1. This is intended to show some features of a vertical section at the fortieth parallel. The left extremity of the diagram is supposed to be in the longitude of the Pacific coast and the positions occupied by the Sierra Nevada, by longitude 117° and by the Wahsatch range are noted. The diagram does not pretend to exhibit the configuration of the land surface, but merely indicates the limits between the land and the sea.

At the close of the Palaeozoic a great change took place in the Pacific slope. Western Nevada with portions of Oregon sank below sea level, while a large part of the sea bed to the eastward rose. The newly elevated area embraced the eastern portion of

Nevada, the western half of Utah, and probably a large part of Idaho. These changes involved movements upon three lines of faulting. Of these one is the Wahsatch fault, on which we know that previous movements had taken place in the Archaean. The second also runs in a northerly and southerly direction crossing the fortieth parallel at about longitude 117°. Here too, motion must have occurred during the Archaean, since otherwise the Palaeozoic sea could not have found a shore at this limit. The third line of fracture is close to the present position of the Sierra Nevada and probably passed along its eastern flank. Fig. 2 shows the relative positions of the sea and land at the close of the Palaeozoic along the fortieth parallel.

The next period after the Palaeozoic is known to geologists as the Jura-Trias. During this time strata were deposited to the east of the Wahsatch and between the Sierra Nevada and longitude 117°. These two seas, however, appear to have been without connection, and the animal remains which they contain are not identical. The fossils in the more western area however are few in number, imperfect and unsatisfactory.

At the close of the Jura-Trias the bottom of this western sea rose again, new movements taking place along the Sierra Nevada and the line of disturbance at 117°. This western Jura-Trias sea was thus obliterated. At the same time the Pacific coast sank beneath the waters of the Pacific Ocean. The fault along the Sierra Nevada on this occasion does not appear to have taken place at its eastern base but along its western flank nearly in the position of the gold belt of California. Its northern extension ran along the Blue Range to the north-eastward. The section along the fortieth parallel after these changes, is represented by Fig. 3, from which it appears that to the east of the Wahsatch the conditions were unchanged.

After the Jura-Trias comes a period called the Cretaceous, because most of the chalk of Europe was deposited during this era. Very early in this period a new change occurred. The coast ranges of California and the cascade range of Oregon were driven up, while a large addition was made to the western flank of the Sierra Nevada. This upheaval was extremely violent. Most upheavals are so slow that the strata of rock, once horizontal,

are merely tilted, bent or crumpled; but in the coast ranges of California the strata for many thousands of square miles were shattered at this upheaval until the average size of the fragments does not exceed the size of a hen's egg. The heat produced by this crushing was sufficient to modify the rocks profoundly and to convert them from ordinary soft sandstones and shales into serpentine and hard granular rocks much resembling those of Newport. The section on the fortieth parallel after this upheaval is represented by Fig. 4.

Soon after this uplift the coast ranges of California and the cascade range, partially subsided and formed more groups of islands. They remained in this condition, with slight changes, throughout the remainder of the Cretaceous period and for long after. At the close of the Cretaceous, however, an immensely important upheaval took place in the heart of the continent, and the entire Rocky Mountain system was brought above water. The area now known as the Pacific slope then began for the first time to drain into the Pacific Ocean. Fig. 5 shows the section at the close of the Cretaceous, and the renewed movement on the old Wahsatch fault.

The periods next succeeding the Cretaceous are the Eocene and Miocene, both very quiet on the Pacific coast. Indeed the Eocene was absolutely continuous with the Cretaceous so that there is no sharp distinction between them. This is a state of things which is known to exist nowhere else in the world except in New Zealand. At the close of the Miocene the Pacific coast rose once more, and land stretched continuously from the Pacific coast to the Rocky Mountains substantially as it does to-day.

A mere glance at the diagram shows that there has been a continuous tendency to the extension of the land area of the region called the Pacific slope from the beginning of the Palaeozoic onward. This is a fact not without parallel elsewhere, but nevertheless of the deepest interest. The whole tendency of external agents is to annihilate land. The waves cut away the shore, the winds blow dust to sea, the frost turns solid rock to sand which the streams carry out to the ocean in vast quantities. It is true that these causes act slowly, but geology reckons by millions of years, and it is evident that were the volume of the

continents not in some way increased, they would be altogether washed away in time. A few million of years would suffice to distribute the material which now stands above water over the sea so that a somewhat shallow ocean would cover the globe. Instead we find that the Pacific slope has actually grown, and that vast areas once covered by water are now dry land. Either the actual amount of material between the surface of this area and the earth's centre has been increased by subterranean transfer, or else this material has increased more in volume by an amount almost incredibly great. It now stands at an average level of perhaps 3,000 feet above the sea, and many other thousands of feet must have been removed by erosion. I can give you no theory of this strange phenomenon. It is one of the aspects of the great problem of upheaval and subsidence which it is the dream of many a geologist to solve.

The mountain system of the Pacific slope is most intimately connected with the great lines of upheaval to which I have called attention. Every one of them is now marked by mountain ranges and the most important ranges of the region—the Wahsatch, the Sierra Nevada and the coast ranges of California, the Cascades and the Blue Mountains—coincide in position with the main system of faults. Of all the chief lines of fault only that crossing the fortieth parallel at 117° is not marked by a mountain range of great importance.

It would be easy to show, were there time to do so this evening, that lines of faulting and mountain ranges are two effects of a single cause and that they should be expected to appear in company. Lines of faulting, however, are permanent; while mountain ranges are, geologically speaking, evanescent. Thus I mentioned a movement on the great Wahsatch fault which occurred in the Archaean. Renewed movement took place on the same line at the end of the Cretaceous on an enormous scale, and no doubt small motions have been frequent. The last is so recent that vegetation has not had time to clothe the scarp. The interval of time since the first of these movements is perhaps 50,000,000 years, time enough for the process of degradation to remove many a range of the size of the Wahsatch. So too there is evidence that the Sierra Nevada has received accessions from beneath

many times by means of renewed upheaval, besides the additions which have been made to its crest in the form of volcanic material. Were the Sierra to receive no accessions of any kind, and therefore gradually yield to the process of erosion, the moisture laden winds from the Pacific would no longer meet a barrier beyond which they can carry only a trifling quantity of moisture, and the desert regions of the interior would be again well watered as we know them to have been during portions of the later geological periods. It is not likely that this happy change will soon occur for at present the Pacific coast appears to be rising.

Before passing to another subject I desire to point out that though the conditions in the Sierra Nevada and along the coast ranges of California are such that no movements along their fault lines during the Archaean can now be demonstrated, there are indirect reasons for believing that these lines of disturbance like those to the east of them existed before the Palaeozoic, and that all the more important portions of the fissure system which has helped to determine the position of the present mountain system were established in the remote antiquity of the Archaean.

The Pacific slope is most famous for its mineral riches and it was noticed twenty years since that the mines lie in belts parallel to the general trend of the mountains. At that time information was too scanty either to define these belts, or to correlate their occurrence with the general geology of the region. Somewhat recently this subject has been taken up again with the advantage of more detailed knowledge. There are it appears four great belts of ore deposits. One of these coincides with the great Wahsatch fault. This produces the lead and silver of Utah. The second runs diagonally through Arizona fron S. E. to N. W. and pursues a northerly course through Nevada. It coincides with the line upon which disturbance took place first in the Archaean and again at the close of the Jurassic. The third ore belt is the gold belt of California lying on the western flank of the Sierra Nevada. This immensely productive chain of ore deposits lies along the fault which took place early in the Cretaceous. The last belt is that in which all the important quicksilver mines of the United States are situated. It lies near the coast of California in the strip of country which underwent such violent dis-

turbance early in the Cretaceous and a more gentle uplift at a later date. This relation is not unnatural. The primary condition for the formation of veins of ore is that fissures should exist, and these are naturally most plentiful where disturbances have been most profound Moreover the deposition of ores, at least in a very large proportion of cases, is dependent upon heated waters containing various powerful chemicals such as sometimes accompany or follow volcanic outbursts. But volcanic rocks are also most frequently and most naturally found where deep fissures establish a connection between the surface of the earth and the profound depths from which lavas emanate. All of the great lines of uplift show abundant traces of former volcanic activity.

It is evident that this relation between the distribution of ores and the main lines of geological structure is of great importance both scientific and economical. Its discovery helps to correct an error; for it has been believed that certain ores occurred exclusively in rocks of a certain age, whereas the truth is that certain physical conditions are required for their formation and deposition irrespective of the age of the rock in which they may be deposited. It is also true that there is more probability of finding productive mines along the imperfectly explored portions of these great lines of disturbance than in any other part of the Pacific slope, and thus geology indicates the path to be pursued in the development of the resources of the country.

On the Pacific slope, as elsewhere, modern science and industrial interests are indissolubly bound together and neither can safely dispense with the aid of the other.

Sept. 3, 1886.

VERTICAL SECTIONS,

DISTRIBUTION OF LAND AND SEA ALONG THE 40th PARALLEL.

THE ORIGIN OF LIFE AND ITS EARLY DEVELOPMENT.

BY DR. WM. DUNCAN McKIM.*

The subject of the evening's lecture may be viewed from two very different standpoints. We may search into the causes of life and its phenomena, when, at once, we find ourselves closely wrapped in mystery, or we may seek to observe the living world as it actually is, in which case, by patient study, our vision becomes clear, and we find that there is something definite to learn and know.

This evening, let us stand well aloof from mere speculation, interesting as this may be, and avoiding the vague and indefinite, let us endeavor to trace, in the domain of actual knowledge, the simple but wonderful plan manifest in the origin and development of vegetable and animal life.

When we write the biography of a man, or the history of a nation's rise and progress, we grasp our theme more broadly if we consider first the previous condition of the environment into which the man was born, or amid which the nation had its first beginnings: in the same way, we shall obtain a clearer view of our subject, this evening, if we consider, for a few moments, the series of changes through which our earth has passed before it was in a condition to give origin and support to life.

Let us, then, go back in thought to the earliest period of which the human mind can, with any distinctness, conceive, and ask how our world arose—and the solar system to which it belongs. The only plausible answer ever given to such a question is that presented by the "nebular theory" of Laplace. The correctness of this wonderful hypothesis, in the nature of things, we can never hope to establish beyond cavil, for there was no one to witness the enactment of the events supposed, nor is the theory susceptible of mathematical demonstration; yet, among scientific men generally, the theory is regarded as being probably in close correspondence with the truth, for it alone can explain an important series of astronomic facts, and no fact has yet been found to weigh against it.

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*Read before the Society, August 6th, 1886.

The nebular theory is, essentially, as follows: in the remote past, there existed a vapor-like mass of incandescent gas which stretched itself in vast dimensions through a part of infinite space.* This nebulous mass had a motion of rapid rotation, with a direction from west to east. Whence the matter came of which the mass consisted, we do not know, nor the source of its intense heat, nor the cause of its rotation. These facts are inscrutable. As the mass revolved, it radiated constantly into space a portion of its heat, whereby it grew less hot, and, like all cooling bodies, was in a state of continual contraction, which implies an increasing density and an ever increasing velocity of rotation. Revolving bodies have a tendency to throw off from themselves the portions about their periphery: this is marked in fluid bodies, and much more so in those of a gaseous consistence. In accordance with this well-known mechanical principle, a ring was given off from the primitive nebulous mass, and, subsequently, a series of rings, all of which continued to revolve about the central mass, and in the same direction as before, i. e. from west to east.† The matter of which these rings consisted being of different density in different places, the denser portions acted as centres of special attraction, the less dense gravitating toward them, until, after a time, the rings were broken into fragments, which latter still continued to revolve, from west to east, about the great mass at the centre, along a course in space before occupied by the parent-rings.‡ But these fragments had acquired still another motion, and now revolved upon their own axes, also from west to east. By the principle already enunciated, many of these revolving fragments now acted as sub-centres for the evolution of rings, and these secondary rings, like the first series, broke into rotating fragments, the direction of motion for these masses, whether upon their own axes or about a parent-body, being always from west to east. This process of ring-making was finally brought to an end by the cooling, and consequent solidification, of the masses. The central body of the nebula became the sun, the fragments of the primary rings, the planets and asteroids, while from the secondary rings arose the planetary satellites.

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*Fig. 1. †Fig. 2. ‡Fig. 3.

Such, briefly stated, is the nebular theory. Among the facts seeming to establish its probability are: the revolution around the sun in the same direction of all the planets, which is the direction, also, of the sun's rotation upon its own axis, and of that of all the planets upon their axes—with the exception of Uranus and possibly Neptune—and of the satellites about their primaries. Further, the orbits of all the planets are in very nearly the same plane, and this plane coincides with that of the sun's equator. A striking illustration of the manner in which our solar system is supposed to have arisen from the original nebulous mass has been given in an experiment devised by M. Plateau. A quantity of oil is poured into a mixture of alcohol and water: the oil sinks to a certain depth, the lower strata of the mixture being heavier, and the upper strata lighter, than the oil, which, in this way, floats free, to a certain extent, from terrestrial gravitation, its particles seeming to be influenced merely by their own mutual attractions, by reason of which the oil-mass assumes a spherical form. It is now gently caused to rotate about its centre, which causes a bulging of its equator and a flattening of its poles—corresponding to the form of our sun and the planets. The rotation now being accelerated, the equatorial portion of the globe is gradually thrown off as a ring, which then continues to revolve about the parent-globe. The rotation of the whole mass continuing, the oil-ring breaks into fragments, and these revolve not only about the central mass, but, also, each upon its own axis, like the planets.

During these transformations assumed by the nebular theory, the many masses, through their constant loss of heat, gradually passed from the gaseous into the liquid or molten condition, and then, first at the surface, solidification began. Our sun is still in the incandescent gaseous condition, losing its heat very slowly, partly because so large, and partly through the fresh generation of heat within it in a way as yet not understood. Our moon has passed through the gaseous and molten stages, and is now a burned out solid, having been so small as to lose its heat with comparative rapidity. Our earth holds a middle position in this respect, having finished, it would seem, the gaseous stage, and being now for the most part molten, with a thin but ever thickening crust of solid matter.

Now let us leave the solar system, and confine our thought to our own earth. At this point, it is well to explain that by heat we mean merely a peculiar kind of motion. The molecules of which a body is composed are in a state of constant motion or vibration: the greater the motion of these particles, the hotter the body seems to us, and the less violent the vibration, the colder the whole mass seems. Now, the chemic force by which atoms combine is exerted only between atoms which are infinitesimally near each other, and so the intense heat which, at one time, prevailed upon the earth, consisting in a violent agitation of the atoms, prevented their remaining sufficiently long in close contact for combination to occur, so that, at this time, the earth consisted of free or uncombined atoms of matter.

At a later stage, the earth having grown somewhat cooler, i. e. the energy of vibration having lessened, it became possible for these primitive atoms, of identical structure and properties, to combine themselves into simple compounds of widely differing qualities. These earliest combinations were, doubtless, the substances which we now term elements—as oxygen, hydrogen, gold, mercury, lead, etc. The so-called elements were believed until very recently to be ultimate constituents of the material universe, simple, uncompounded, indivisible—but, through the spectroscope, it has become almost certain that they are really compounds, quite separable into their components by intense heat. Thus, in the laboratory, by the heat of the Bunsen burner, several of the elements can be resolved, and the constituents recognized by the spectroscope; others by the more intense heat of the electric arc; while still others of our elements may be discerned in the sun as undergoing through its fervent heat a dissociation which could never be accomplished amid the conditions known to us upon earth.

As the primitive temperature lessened still further, the "elements" began to combine, and the resulting compounds gradually became more and more complex: first such simple and more stable compounds, as water, H_2O, and the inorganic acids, carbonic acid, CO_2, nitric acid HNO_3, sulphuric acid, H_2SO_4; then the more complex salts, as sulphate of calcium, $CaSO_4$, chalk, $CaCO_3$; then the more complicated compounds

of organic life, as starch, C6 H10 O5, grape-sugar, C6 H12 O6 cane-sugar, C6 H22 O11; and finally, the most highly complex of the organic compounds, as cerebrin, C57 H110 N2 O25 (a substance found in the brain), and protagon, C160 H308 N5 PO35 (a constituent of nerves).

How the transition from the non-living to the living was first effected, we do not know. Whether life first appeared in dead, insensate, matter by a creative fiat, or whether it began to dawn as the result of increasing complexity of chemical combination, the mystery is alike inexplicable. Let us, then, not pause here, but go on to trace and depict the scheme of life's origin and development as we know it to-day.

Animals and plants are made from a material which, in its essential character, is common to them both. This material from which they are both built up, this physical basis of life, is known as *protoplasm*.* Protoplasm, then, is the simplest form of living matter: as the atom is the unit in chemistry, so protoplasm is the unit in the world of life, and the most complex of living things is but an aggregation of protoplasm. I should now impress upon you the properties of protoplasm, for the highest forms of vegetable and animal life have no other properties than these. The most marked characteristics are as follows: Protoplasm has the property of taking up, and making part of itself, other living or non-living matter, whereby it grows; on reaching its maturity, it is able to reproduce one or more individuals like itself; it then undergoes a retrograde transformation, its activity diminishes, and it dies. This series of changes through which each individual mass of living matter must pass—growth, reproduction, and death—is most distinctive. A second property of living matter is its irritability. If anything comes into contact with protoplasm, there is an instant change of its latent into actual energy, expressed by motion, or by heat, light, or electricity.

Another peculiar function is the power of automatic motion. If we observe a mass of protoplasm under the microscope, we shall see an almost constant motion in it—a gliding or outstretching of some portion of its substance. A fourth characteristic is the extremely complex chemical composition of protoplasm.

*Fig. 4.

These being its principal distinctive features, how does the unit of living matter appear to the eye? It presents itself as an extremely minute, translucent, jelly-like mass, visible only by aid of the microscope, at times perfectly structureless, more frequently containing within it granules of different sizes, with a dense portion known as the nucleus, and within this, often, a darker spot termed the nucleolus. It may have formed for itself a limiting membrane or "cell-wall," as is the rule with vegetable protoplasm, or not, as we find in the protoplasm of animals. Such a living unit, in spite of its simplicity, is a perfect organism of its kind, possessing, although in lowly degree, all the functions of life. From a single, simple mass of this kind develops every living thing.

For convenience in study, we divide the living world into two great kingdoms—the vegetable and the animal, but the borderline between the two is not clearly defined. When a creature very low in the scale of life presents itself, it is sometimes impossible to determine whether it be a protozoan or a protophyte —the lowliest of animals or of plants. The main difference between the two kingdoms is that plants take their food directly from the inorganic world, while animals, unable to do this, feed upon vegetable, or other animal, matter; but this rule does not always hold, and hence our difficulty.

Now, I have said that every living thing has its origin in a single unit of protoplasm; let me trace for you, in a simple way, this marvellous process of development, as seen in plants and animals, taking, for illustration, a lower and a higher representative of each kingdom.

Among the lowest of plants are the bacteria, which are simple unicellular organisms, i. e. each individual consisting of but one protoplasmic cell.* Many of them are so small that they can barely be seen even with the highest powers of the microscope. Their mode of reproduction is very simple. In some cases, the parent-organism gradually elongates, through increase in the quantity of its living-matter, or protoplasm, until its former length has been about doubled; then a gradual constriction of the bacterium is observed to occur at its middle, which increases until the

Fig. 5.

two halves are constricted asunder into two complete individuals, each perfect in form and function. Another mode of reproduction consists in a gradual elongation of the organism, as already described, but to a greater extent, after which appear dark bodies within the living-matter—the so-called spores—and, these having reached a relatively large size, the investing membrane of the parent-plant ruptures, and the spores are scattered as new individuals, each retaining about it a portion of the protoplasm which surrounded it while yet a part of the parent. The reproduction of these bacteria is very rapid, when the environment is favorable, and, for many varieties, a half-hour suffices. Of late years, these minute organisms have been found to be the causative agents of many dire diseases, the rapid progress of which is more clearly understood when we observe the wonderful activity of reproduction among certain classes of bacteria.

Now, let us turn our attention to the more complicated system of development found in the majority of "phaenogamous," or flowering, plants, which likewise take their origin from the single cell or unit of protoplasm. To make the process more intelligible, I present a diagram recalling to your minds the essential parts of a flower—sepals, petals, stamens, pistils.* The pistils, as indeed, all the parts of the flower, are merely modified leaves.† In each of the pistils, along the line of union of the margins of the original leaf, appear a series of outgrowths, known as ovules, the portion first appearing being termed the nucleus or body of the ovule. From the base or attached portion of the nucleus, there grow out two coats about the nucleus, gradually enclosing it, there remaining, however, an opening in this envelope termed the foramen, which is found just over the apex of the nucleus. When complete, then, the ovule consists of a nucleus and (usually) two coats, which latter present an orifice over the apex of the nucleus. A cavity (the embryo-sac) now forms within the nucleus, and, from some portion of the protoplasm lining it, a single protoplasmic cell, of globular form, is thrown off, termed the embryonal vesicle, and this rises to the apical portion of the sac. The ovule is now mature, and fertilization is brought about

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* Fig. 6. † Fig. 7.

in the following way: a grain of pollen, from one of the stamens, is deposited upon the upper extremity (the stigma) of the pistil, the moisture of which stimulates an outgrowth from the pollen-grain of a tube-like character—the pollen-tube, which makes its way, by growth, down through the loose cellular tissue composing the shaft or style of the pistil, until, finally, it penetrates through the foramen of the ovule, and comes to lie in close contact with the apex of the nucleus of the ovule, just outside of the embryonal sac, and close to the embryonal vesicle.* With this latter, doubtless, the protoplasm of the pollen-tube comes into actual contact, whereby the protoplasm of the embryonal vesicle is incited to develope. This embryonal vesicle, it must be remembered, is merely a single unit of protoplasm, corresponding to the single cell of the bacterium, the development of which by simple enlargement, constriction, and division into two has already been described. This similar single cell in the higher plant enlarges and subdivides in precisely the same way, but the new cell-units, instead of falling apart, remain bound in close apposition, and through their aggregation eventually form living masses of the most varying shapes and dimensions. To describe the process a little more in detail, the first cell of the germ of the coming plant—the embryonal vesicle—enlarges and divides into two cells, each of these two then grow and subdivide, making four, and by a continuance of this process a protoplasmic chain is formed, the terminal cells of which, after a certain length has been reached, then beginning to put out their offspring in three directions, whereby the germ, or embryo as it now comes to be called, acquires length, breadth, and thickness. In a little while the newly-forming cells cease to cohere along a certain line, or, in other words, the mass of the embryo in its later growth developes as two halves, which lie flattened out upon each other, ever curling more and more as restricted by the narrow confines of the ovule.† The protoplasmic chain spoken of corresponds to the little stem of the embryo or plantlet, while the separate halves become the leaflets or cotyledons of the young plant. We have seen, now, how through fertilization of the ovule the primitive germ-cell has

* Fig. 8. † Fig. 9.

developed by cell-division and multiplication into the embryo. As a further step, nutrient matter is deposited either within or around this embryo, and then the ovule is said to have become a seed, at which time, it consists of a nucleus or kernel, with, as a rule, two coats, the nucleus being made up of the embryo alone, or of this with nutrient matter about it, generally granules of starch in the mesh of a cellular structure.

The seed contains living matter in the form of its embryo, and this is a strange instance of a dormant or potential and not actual life, for the embryo may remain for years apparently unchanged and inactive, and yet awaken into vigorous life when surrounded by the conditions which its activity requires, viz., moisture, free oxygen, and warmth. It has been found that forty-five years is about the extreme limit of the period through which a seed may preserve its vitality, the longevity, so to speak, varying greatly for different varieties of seeds. The statement that wheat-grains found entombed with Egyptian mummies have been planted and caused to grow seems to have no satisfactory foundation.

The seed being supplied with the proper conditions, the germ or embyro continues to develope, the process of germination begins. The starch about the germ is converted into dextrine and glucose, which being freely soluble in water, as the starch was not, are now absorbed by the cells of the embyro and utilized as food, whereby these protoplasmic cells enlarge and then multiply. In this way, the stemlet lengthens, the cotyledons unfold and enlarge, and a rootlet begins to form. The stemlet soon raises the seed-leaves above the surface of the soil, which then are spread out in the sunlight and air, and, from this time, the plantlet is able to support itself by materials obtained from soil and air, whereas, before the emergence of the seed-leaves into the sunlight, the abundance of food about the root, even if absorbed, could not be assimilated by the plant, the process of digestion being effected in the leaves, through the influence of the so-called actinic or chemic rays of the sun.

Having traced the development of life in the higher plants, as far as time will permit, let us look at the processes of early life in a lower and higher animal form.

The protozoa, or lowest of animals, like the lowest plants,

consist of single cells of protoplasm, but differ in this respect that the animal-cells have no limiting membrane as is the rule with the protophytes. The mode of reproduction is, practically, identical with that described for the lowest plants, and, therefore, I need only say that it consists in enlargement by growth of the parent-cell and a subsequent constricting off of a smaller or larger portion of its substance, whereby a new individual is produced.

To illustrate the mode of development from the single cell of the higher animals, I shall select the common chicken, since I am able to present specimens of the living embryo at different stages of incubation.

The origin of the chick is from an extremely minute unit of protoplasm, looking, at first, as seen in the parent-bird, like the cells which are to develope into muscle or nerve, or any other tissue, but soon becoming slightly larger, and sufficiently modified to indicate its higher destiny. After a time this little cell is surrounded by an enormous quantity of nutritive material, intended to support its growth during the period of incubation, and this whole mass we term an egg.* When the time has come for the development of this germ-cell, its protoplasm divides into two halves, each of these into two again, making four, and so on, until we have spread out upon a small area of the nutritive mass of the egg a layer of germinal or embryonic cells, constituting by their aggregation a membrane.† This membrane constantly enlarging in every direction, by the multiplication of its constituent cells, soon shows a cleft of separation in its mass, after which it continues to grow as two portions, although these remain attached at the site of their earliest growth; in other words, the embryonic cells are now arranged in two parallel layers or membranes, which correspond to the two seed-leaves, or cotyledons, of the plant-embryo within the seed. Later, an intermediate membrane is put forth by the embryonic mass between the first two, and, at a still later stage, by a rift in this third layer it is converted into two, and so the embryo is found to consist of four membranes. By the subsequent thickening and folding of these four layers, in various ways, the whole body of the chick is finally built up.

*Fig. 10. †Fig. 11.

Thus, along the surface which is to be the back of the chick, two longitudinal ridges appear, one on either side of the middle line, these thicken, become more elevated, converge, and finally join, enclosing a tubular cavity, which with its walls becomes the brain and spinal cord. Along the front, the two innermost membranes fold more and more inward until their two sides coalesce along the middle line, making a tube—the subsequent digestive canal. The two outer membranes also fold inward, but in a wider sweep, the two sides ultimately coalescing along the middle line, also, to make the general cavity of chest and abdomen, and, as will be understood through their broader sweep, enclosing the digestive canal.* Later, the protoplasmic cells constituting these membranes, tubes, etc., which, originally, were precisely alike in appearance and function, gradually become transformed in these two respects, according to their locality—becoming "specialized," as we say. Thus, while every cell has all the properties of protoplasm, one cell will show a higher development of one property, while a second will be specially characterized by some other attribute. For example, every cell of living-matter has the power of automatic motion, but the cell which forms part of a muscle has this very markedly developed. Again, every living cell is "irritable," by which we mean having the power to react when anything comes into contact with it, its latent energy instantly being converted into an actual form; this function is most marked in the cells of the nervous system. To present a brief statement of the transformation incident to the development of life in the higher animals, we may say that by the multiplication of the cells which are the offspring of the original *one*, the formation of four membranes, the thickening and folding of these, and the specialization of cell-functions, the complete animal is developed.

The subject of the development of living things is an extremely complex one, requiring close study for its comprehension, and, in this evening's lecture, with limited time, and few means of illustration at my command, I have not expected to carry you far into this most interesting study, but the broad principles of the plan according to which life developes are very simple, and I therefore

*Figs. 12 and 13.

cherish the hope that I may have presented them with sufficient clearness to give you some definite knowledge of this mystery, and to awaken in you a desire to pursue the study further for yourselves.

EXPLANATION OF FIGURES.

FIG. 1. Diagram representing primitive nebula, the arrows indicating direction of rotation.

FIG. 2. Diagram representing first ring thrown off by rotating nebula. 1, Central mass. 2, Ring. 3, Denser portion of ring.

FIG. 3. Diagram representing the breaking of a ring through the aggregation of matter about the denser portions.

FIG. 4. Diagrams of an amœba, a low form of animal consisting of single "cell" of protoplasm, illustrating the appearance of living matter—its structure and the peculiar transformations of shape of which it is capable.

FIG. 5. Diagram illustrating development of bacteria. 1, Globular bacteria. 2, The same, after enlargement, constriction, and separation into two individuals. 3, Rod-shaped bacteria. 4, The same, after elongation and formation of spores.

FIG. 6. The essential parts of a flower. 1, Pistil. 2, Stamen. 3, Petal. 4, Sepal. 5, Torus or receptacle. [After Gray.]

FIG. 7. 1, Diagram of incurving leaf, to illustrate formation of pistil. 2, Pistil cut transversely, to show two ovules in situ. Near upper end of pistil, the union of incurving edges of the original leaf is incomplete, leaving an orifice through which, later, the fertilizing tube of pollen-grain may descend. [After Gray.]

FIG. 8. Diagram representing pistil opened by longitudinal section, to show ovule ready for fertilization. 1, Nucleus of ovule, invested by its two coats. 2, Embryonal sac. 3, Embryonal vesicle. 4, Pollen-tube. [Modified from Gray.]

FIG. 9. Diagram of the plant-embryo, at different stages, during germination of the seed; 1, Representing the cellular structure. 2, The actual appearance. [After Gray.]

FIG. 10. Diagram representing egg of chicken. 1, Albumen. 2, Yolk. 3, Germ-cell.

FIG. 11. Diagrams to illustrate developement of germ-cell. The yolk is presented in transverse section, without its investment of albumen. *A*, Germ-cell has enlarged, and divided into two.

B, From these two have arisen many cells, which are now spread as two membranes. *C*, The multiplication of cells has continued, and between the two membranes first formed a third membrane has arisen, and this one splitting into two, on each side, close to the middle line, four membranes result; by the thickening and folding of which in various ways, the subsequent embryo is formed.

FIG. 12. Transverse section of yolk at stage more advanced than *C*, Fig. 11. The cellular membranes are represented by the curving lines. 1, Spinal-cord tube, nearly closed. 2, Digestive canal. 3, Cavity soon to be closed in, as chest and abdomen. 4, Yolk-cavity.

FIG. 13. More advanced stage of Fig. 12. The numbers refer to same parts as in the preceding figure.

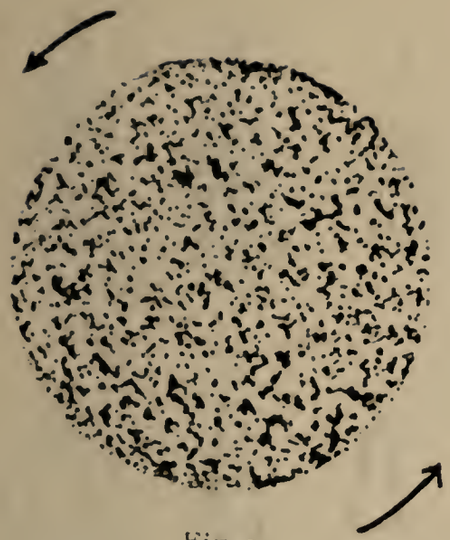


Fig. 1.

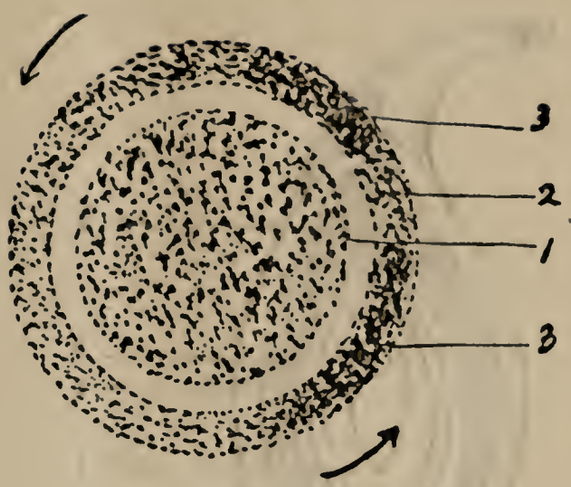


Fig. 2.

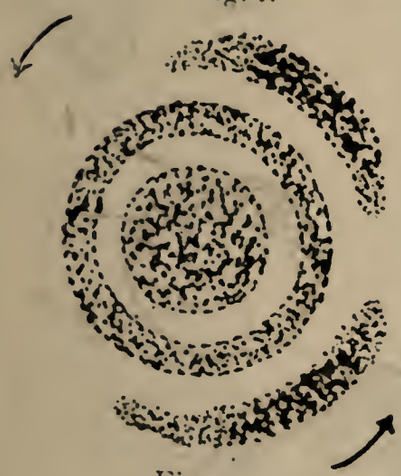
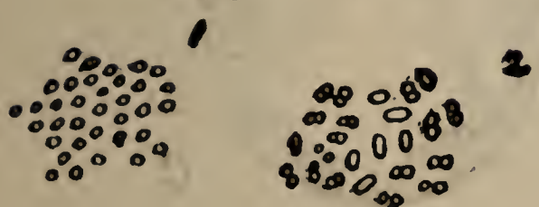


Fig. 3.

Fig. 4.



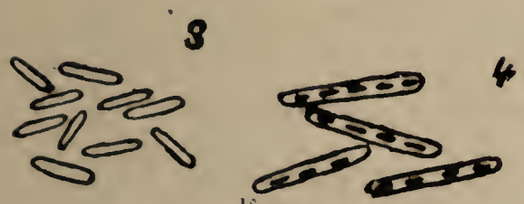


Fig. 5.

Fig 6

Fig. 7.

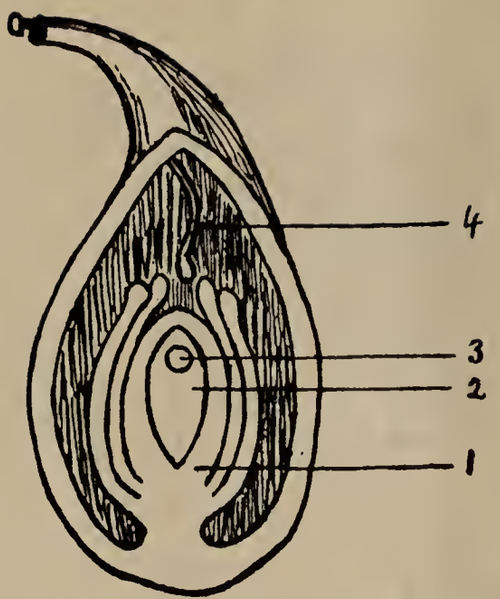


Fig. 8.

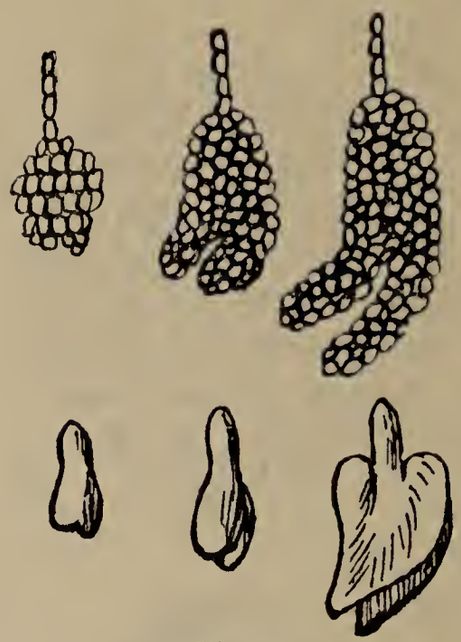


Fig. 9.

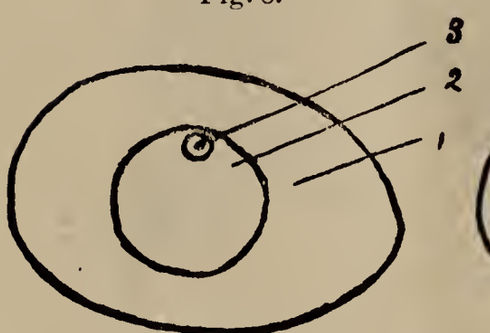


Fig. 10.

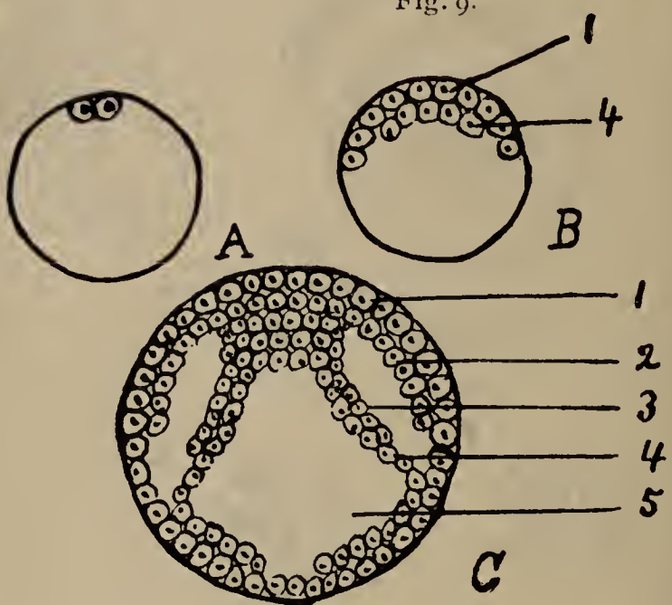


Fig. 11.

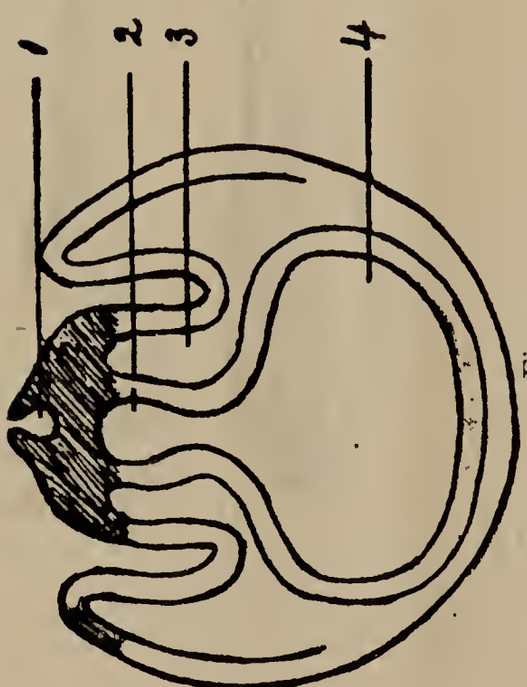


Fig. 12.

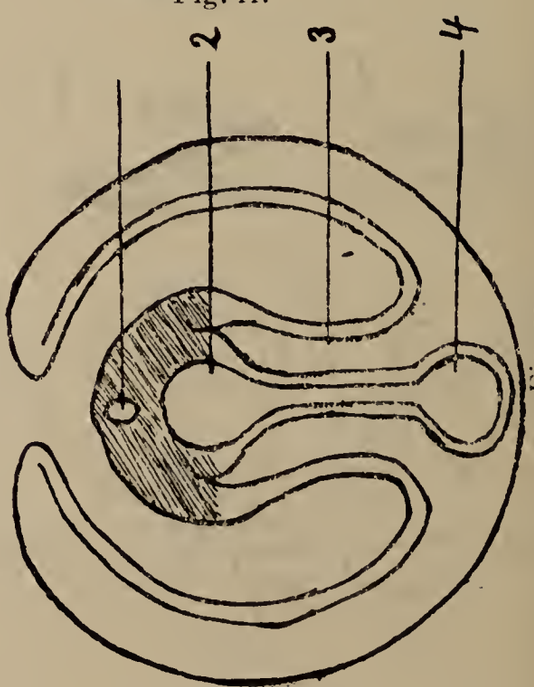


Fig. 13.

LIST OF MINERALS AND ROCKS

Occurring in the Vicinity of Newport.

The following list of minerals and rocks includes those found by the writer in the course of his geological studies about Newport. It is quite probable that it does not represent all that actually occur in the region, but at all events it includes those of common occurrence. The order is alphabetical. Only the principal localities are given:

MINERALS.

NAME.	LOCALITY.
Anthracite (plumbaginous).	Portsmouth, Coal Mines.
Asbestos.	Portsmouth.
Calcite.	Portsmouth, Castle Hill, Moorland Road.
Chlorite.	Paradise, Castle Hill, Rose Island.
Chlorite (partial pseudomorphs after Garnet and Staurolite).	North Conanicut (west side).
Chrysotile.	Newport Neck.
Dolomite.	Lime Rock, Fort Adams.
Epidote.	Conanicut, near Dumplings.
Feldspar (Crystals, species not determined).	Castle Hill, Bailey's Beach, Paradise.
Fluorite (traces).	Newport Neck in Flinty Slate.
Garnet (Crystals).	N. Conanicut (west side), Dutch Island.
Jasper.	Newport Neck, Fort Adams.
Magnetite (Crystals).	Purgatory, Berkeley Rock, Brown's Point.
Mica (two species Crystals).	Paradise, Watson's Pier in S. Kingstown.
Ottrelite (Newportite Crystals).	N. Conanicut (west side).
Picrolite	Newport Neck (north shore).
Plumbago (granular).	Narrow River, N. Kingstown.
Pyrite (Crystals).	Easton's Point, S. Conanicut (west side).
Quartz (pellucid Crystals).*	Narraganset Shore, "Cliffs."
" (milky).	"Cliffs," Sachuest Neck.
Serpentine (green).	Newport Neck.
" (dark purple).	Brenton's Cove.
Siderite.	Mackerel Cove (west side). Portsmouth Coal Mine, (Crystals).
Staurolite (twins and trillings).	N. Conanicut (west side).
Talc.	Brenton's Cove, Sachuest Neck.
Zoisite (Crystals).	Paradise.

*In this connection some large Crystals of pellucid Quartz traversed by acicular crystals of Hematite or Actinolite found quite recently by Mr. Hugh L. Taylor, in a Quartz vein of the Conglomerate of the Carboniferous Series, ought to be recorded.

ROCKS. (In Situ.)

NAME.	LOCALITY.
ARGILLYTE, SLATE.	"Cliffs," Easton's Point.
" CARBONACEOUS.	North of Brown's Point, "Cliffs," Wood's Castle.
" CHLORITIC.	Newport Neck, Brown's Point.
" HEMATITIC.	Wood's Castle.
" OTTRELITIC.	North Conanicut (west side.)
" PLUMBAGINOUS.	" " " " Portsmouth Mine.
" SIDERITIC.	North Conanicut, Mackerel Cove.
" SILICEOUS.	Newport Neck.
" STAUROLITIC and GARNETIFEROUS.	North Conanicut (west side).
" TALCOSE,	Graves' Point.
" BRECCIA (Ferruginous Cement).	Sakonnet River (west shore).
CHLORITE SCHIST.	Dumplings, Paradise.
CLAY, BLUE	Sakonnet River (west shore).
GNEISS.	Narragansett Pier, Bristol.
GNEISS (Protogine).	" " Newport Neck.
GRANITE.	Boston Neck, The Bonnet, Tiverton.
GRIT, METAMORPHIC	Sachuest Neck, Tiverton.
HORNBLENDE SCHIST, (Possibly an altered igneous rock).	Paradise.
HYDRO-MICA SCHIST.	South Conanicut (east side).
MICA SCHIST.	Paradise, Packard's Rocks, Wickford.
" " (Hornblendiferous).	Dutch Island.
" (Garnetiferous).	North Conanicut (west shore).
PROTOGINE, (Porphyritic).	Near Fort Dumpling, Bailey's Beach.
QUARTZ BRECCIA (Ferruginous Cement).	Sakonnet River (west shore).
QUARTZYTE CONGLOMERATE.	Purgatory, Coaster's Harbor Island.
" " (Micaceous).	Purgatory, Paradise.
SANDSTONE (Argillaceous).	Wood's Castle.
SILICEOUS SCHIST.	Paradise.

BOULDERS. (Found in southern parts of Islands of Aquidneck and Conanicut.)

ARGILLYTE (Ottrelitic) rarely with plant impressions.
DOLERYTE (Amygdaloidal).
FELSYTE, (Porphyritic).
GRANULITE.
GRIT AND CONGLOMERATE, with stems of coal plants.
HORNBLENDE (Garnetiferous).
LABRADIORYTE (Porphyritic).

Limestone (Crinoidal, reddish). Found by Mr. Alex. Peckham.
Quarezyte (Micaceous with Lingulae). Sachuest Neck.
Quartzyte (Tourmalinic).
Syenite.
Titanic Iron (Feldspathic).

Toronto, Canada, May 29th, 1885.
Revised, Newport, April, 1887.

T. NELSON DALE.

NATIVE PLANTS OF THE ISLAND OF RHODE ISLAND.*

III.

PAPAVERACEÆ.

Chelidonium majus, Celandine.

CRUCIFERÆ.

Sisymbrium officinale, Hedge Mustard.

Cakile Americana, Sea Rocket.

DROSERACEÆ.

Drosera longifolia, Sundew.

HYPERICACEÆ.

Hypericum corymbosum, St. John's Wort.

Hypericum mutilum, St. John's Wort.

Hypericum Canadense, St. John's Wort.

Elodes Virginica, Marsh St. John's Wort.

ANACARDIACEÆ.

Rhus Toxicodendron, Poison Ivy.

VITACEÆ.

Ampelopsis quinquefolia, Virginia Creeper.

ACERINEÆ.

Acer rubrum, Red Maple.

POLYGALACEÆ.

Polygala polygama, Milkwort.

LEGUMINOSÆ.

Medicago lupulina, Black Medick.

Vicia Cracca, Tufted Vetch.

Apios tuberosa, Ground Nut.

Baptisia tinctoria, Wild Indigo.

ROSACEÆ.

Geum album, White Avens.

Geum strictum, Avens.

Potentilla argentea, Silvery Cinque-foil.

Cratægus oxyacantha, English Hawthorn.

Pyrus arbutifolia, Choke Berry.

SAXIFRAGACEÆ.

Ribes hirtellum, Wild Gooseberry.

CRASSULACEÆ.

Sedum telephium, Garden Orpine.

HALORAGEÆ.

Proserpinaca palustris, Mermaid Weed.

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*Arranged by W. C. Rives, Jr., M. D., with the assistance of Prof. W. W. Bailey, by whose aid almost the whole of this list has been prepared. Acknowledgements are also due to C. G. Betton, Esq.

ONAGRACEÆ.

Circæa alpina, Enchanter's Nightshade.

CORNACEÆ.

Cornus Canadensis, Dwarf Cornel (Portsmouth).

Cornus paniculata, Panicled Cornel.

Nyssa multiflora, Black Gum.

CAPRIFOLIACEÆ.

Viburnum dentatum, Arrow-wood.

RUBIACEÆ.

Mitchella repens, Partridge-berry (Portsmouth).

COMPOSITÆ.

Sericocarpus conyzoides, White-topped Aster.

Erigeron strigosum, Daisy Fleabane.

Diplopappus linariifolius, Double-bristled Aster.

Antennaria margaritacea, Pearly Everlasting.

Cnicus horridulus, Yellow Thistle.

Tanacetum vulgare, Tansy.

Hieracium Canadense, Canada Hawkweed.

Hieracium scabrum, Rough Hawkweed.

Nabalus fraseri, Lion's Foot.

Lactuca Canadensis, Wild Lettuce.

ERICACEÆ.

Gaylussacia resinosa, Black Huckleberry.

Vaccinium corymbosum, Swamp Blueberry.

Andromeda ligustrina, Lyon's Andromeda.

Kalmia angustifolia, Sheep Laurel.*

Azalea viscosa, White Swamp Honeysuckle.

Pyrola elliptica, Shin-leaf (Portsmouth).

AQUIFOLIACEÆ.

Ilex verticillata, Winterberry.

PLANTAGINACEÆ.

Plantago Patagonica, Plantain.

PRIMULACEÆ.

Lysimachia stricta, Loosestrife.

Lysimachia nummularia, Moneywort Loosestrife (Bailey's Beach).

Lysimachia vulgaris, European Loosestrife (Roadside in Middletown).

SCROPHULARIACEÆ.

Verbascum blattaria, Moth Mullein.

Linaria Canadensis, Wild Toad Flax.

LABIATÆ.

Pycnanthemum incanum, Mountain Mint.

Nepeta Cataria, Catnip.

Scutellaria galericulata, Common Skullcap.

*Kalmia Glauca recorded in the list in Document 3, should probably be omitted.

CONVOLVULACEÆ.

Convolvulus arvensis, Birdweed.

Convolvulus sepium, Hedge Birdweed.

POLYGONACEÆ.

Polygonum arifolium, Halbert-leaved Tear-thumb.

Polygonum dumetorum, Climbing False Buckwheat.

LAURACEÆ.

Sassafras officinale, Common Sassafras.

CALLITRICHACEÆ.

Callitriche verna, Water Starwort.

URTICACEÆ.

Morus alba, White Mulberry.

Urtica dioica, Nettle.

MYRICACEÆ.

Comptonia asplenifolia, Sweet Fern.

BETULACEÆ.

Alnus incana, Hoary Alder.

CONIFERÆ.

Juniperus virginiana, Red Cedar.

TYPHACEÆ.

Typha angustifolia, Narrow-leaved Cat Tail.

Sparganium eurycarpum, Bur Reed.

ALISMACEÆ.

Triglochin maritimum, Arrow Grass.

ORCHIDACEÆ.

Habenaria virescens, Green Rein Orchis.

Habenaria lacera, Ragged Fringed Orchis.

Arethusa bulbosa, Arethusa.*

Pogonia ophioglossoides, Snake Mouth.

Calopogon pulchellus, Grass Pink.

AMARYLLIDACEÆ.

Hypoxis erecta, Star Grass.

IRIDACEÆ.

Iris virginica, Slender Blue Flag.

Sisyrinchium anceps, Blue-eyed Grass.

SMILACEÆ.

Smilax rotundifolia, Common Greenbrier.

LILIACEÆ.

Veratrum viride, White Hellebore.

Maianthemum bifolia, False Solomon's Seal.

Polygonatum biflorum, Smaller Solomon's Seal.

Hemerocallis fulva, Day Lily.

PONTEDERIACEÆ.

Pontederia cordata, Pickerel Weed.

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*Rare. Found by Messrs. C. G. Betton and John Powel.

GRAMINEÆ. (Grasses).

PHLEUM PRATENSE, Timothy.
SPARTINA POLYSTACHYA, Salt Reed Grass.
GLYCERIA OBTUSA, Manna Grass.
TRITICUM REPENS, Couch Grass.
HOLCUS LANATUS, Velvet Grass.

FILICES. (Ferns).

ASPLENIUM TRICHOMANES, Dwarf Spleenwort.
ASPLENIUM EBENEUM, Ebony Spleenwort.
ASPLENIUM FILIX-FŒMINA, Lady Fern.
ASPIDIUM MARGINALE, Evergreen Wood Fern.
DICKSONIA PUNCTILOBULA, Hay Scented Fern.
OSMUNDA REGALIS, Royal Fern.

LYCOPODIACEÆ. (Club Mosses).

LYCOPODIUM INUNDATUM, Marsh Club Moss.
SELAGINELLA RUPESTRIS, Rock Club Moss.

PRESIDENT'S REPORT.

In accordance with the rules of the Natural History Society of Newport, it is one of the duties of the president of the Society to make a report of the Society's proceedings during the year at the annual meeting, and the following report for the year 1886–87 is therefore submitted:

Since the last annual meeting of the Society in May, 1886, the following papers have been read at the regular meetings, of the society, viz.:

1st—On June 5th, 1886, by Capt. J. P. Cotton, on "Water Supply."

2nd—On June 29th, 1886, by Professor T. Nelson Dale, on "A Geological Ramble through the Tyrol."

3rd—On August 6th, 1886, by Dr. McKim, of New York, on "Origin of Life and its Early Developments."

4th—On September 3rd, 1886, by Mr. Charles Lawton, on "Ornithological Notes on the 'Shore Birds' of Newport Bay," and by Mr. A. O'D. Taylor, on "The Extinction, within Historic Times, of Certain Wild Animals in a Corner of Europe."

Arrangements were also made by the council for two educational courses of lectures by Professor T. Nelson Dale, who, accordingly, delivered a series of seven (7) lectures on "Geology," weekly, on Saturday evenings, commencing February 12 and ending March 26, 1887; and a series of four (4) lectures on "Cryptogamic Botany," commencing April 2 and ending April 23, 1887. These lectures were remarkably well attended, and the council believes that their specially educational character contributed largely to their success.

On October 1, 1886, an arrangement was made with the Newport Historical Society to rent from them for one year, a part of the available space in the Barney street Hall for the display of the Natural History Society's collections, the arrangement also to include accommodations for whatever meetings the Natural History Society might wish to hold during those twelve months.

The arrangement has proved satisfactory. The attendence at the various meetings has been larger than when they were held in

the Redwood Library, and the fact that donations can be arranged and exhibited for reference in an appropriate building, even if their deposit there be only temporary, serves to strengthen the belief that our local Natural History Society is gradually emerging into a condition of more enduring usefulness.

During the past year Document No. 4 has been issued as a part of the Society's proceeding—covering 1885 to 1886, and, as an instalment of Document No. 5, one of the papers mentioned in the list for 1886-87 has already been published.

The Treasurer's account, herewith submitted, shows an improved state of finances; but there should be an accession of members, both from Newport residents and those ladies and gentlemen who only spend part of the year here, and it is to this natural and proper source of increased income that the council looks for that permanent support which the local Natural History Society of Newport ought to receive.

In closing this brief report of the last year's proceedings, the President of this Society desires to publicly express his high appreciation of the many, and great, obligations under which he finds himself placed to the Curator, Mr. A. O'D. Taylor, for his invaluable, kind and voluntary assistance in every and all ways, in aiding him in the discharge of his duties; and, at the same time, without desiring to particularize invidiously, or at any one's expense or disparagement, to congratulate this society on possessing an officer and member who is so devotedly interested in its well-being and who never wearies in its service.

In conclusion, the President returns his thanks to the members of this Society for the high compliment paid him by his election to that office the past year, and desires to express an earnest hope that the year now beginning may prove one of increased prosperity, membership and interest in the objects of the Society; and further, that having survived the struggle that is inevitable in starting such an organization, a prosperous and useful career may be before it, for many years to come.

Respectfully submitted,

JOHN HARE POWELL,

President Natural History Society.

Newport, May 5, 1887.

CURATOR'S REPORT.

This is the third annual report which I have had the honor to lay before the Society, and the first one in which a distinct step can be recorded, in the direction of arrangement.

In October, 1886, we hired from the Historical Society, a space in their Barney street Hall, sufficient to permit the erection of two small glass cases, and some shelving suitable for the reception of specimens. Shortly afterwards, the removal of our possessions from their temporary place of storage in Travers Block took place, and, during the past six months, they have been unpacked and placed in position.

Professor T. Nelson Dale having kindly offered his valuable services as a geologist to name and classify the local rocks, fossils and minerals, his offer was gladly accepted, and the result can now be seen in a series of twenty-six different geological specimens carefully named and arranged in one of the cases. A special book, to serve as a catalogue of reference, has also been opened and commenced by Professor Dale with a full record of these specimens.

Another branch of our local natural history has been started by my having arranged, in the same case, a small collection, duly named, containing some twenty species of our Rhode Island shells.

Some specimens of our native birds, and of their eggs, of mammals and reptiles, fishes, insects and plants, have appeared sparingly from donors, so as to warrant the hope that, in due time, some of our members will determine on taking up systematically some one of the groups indicated and endeavoring to gather for the Society a representative series of specimens. It will be by quiet and assiduous efforts that our collections must grow, and through the personal study and investigations of our members, if one of the objects of our Society, namely, self-improvement in the knowledge of natural history, is to be attained.

To be practical and direct, I would therefore venture to suggest that our local ornithologists should undertake, before this day twelvemonth, to present to the Society a few specimens illus-

trative of all or most of the great orders of birds, 1st, the passeres, or passerine birds; 2d, the picariæ, or picarian birds; 3d, the psittaci, or parrots; 4th, the raptores, or birds of prey; 5th, the columbæ, or doves; 6th, the gallinæ, or gallinaceous birds; 7th, the limicolæ, or shore birds; 8th, the alectorides, or cranes and rails; 9th, the lamellirostres, or anserine birds; the steganopodes, or totipalmate birds; 11th, the longipennes, or long-winged swimmers; 12th, the pygopodes, or diving birds. I only ask for two species of each order; and I specify the orders to show that it is on scientific lines our collections should be formed so as to possess an educational value for reference. I recommend the attempt to be made with birds, first, because the avi-fauna of Newport is very extensive; secondly, because there are several gentlemen in our Society who are much interested in ornithological pursuits, and thirdly, I admit, because ornithology has been to me, for many years, a fascinating study. From Rhode Island, specimens of all these orders can be had, except of the parrots.

It is by such combined efforts that our museum can mould itself into shape. Every branch of natural history has, probably, its unknown votaries in Newport. What we aim at is to induce such ladies and gentlemen to work for the public good. To name but one other branch, that of botany; the formation of a "hortus siccus," or dried collection of native wild flowers and plants, is one that might well be undertaken by the lady members of our Society.

At present, we have, apart from the small portion classified, a general collection of minerals, foreign shells and curiosities, many of them of interest but not all coming under the character defined by the sentence in article I, section V, of your by-laws, the words running thus: "Only such objects shall be admitted to the museum as have a scientific value."

As time goes on, the necessity for rigidly abiding by this wise rule will become more and more apparent. During the past year several donations of scientific value have been received and have been, from time to time, duly acknowledged in the public prints, with best thanks to the donors.

I write this third report as your Curator, with more hope than ever before, that, in process of time, we shall have a Natural History Museum in Newport. Your most obedient servant,

NEWPORT, May 5th, 1887. A. O'D. TAYLOR, Curator.

LIBRARIAN'S REPORT.

I have a complete list of the library in preparation and it will be soon completed. During the year various valuable periodicals and Transactions of Societies have been received as hitherto. The Journal of Comparative Medicine and Surgery; the New York Miscroscopial Journal; The Journal of Mycology; Transactions of Vassar Brothers Institute (Scientific Section); Proceedings of Canadian Institute, Toronto; Journal of Cincinnati Society of Natural History; Journal, also Proceedings of Asiatic Society of Bengal; Bulletins and Monographs of the United States Geological Survey; U. S. Engineering and Mining Journal, a series of scientific pamphlets from Dr. Wolcott Gibbs; Notes on the Petrography of the Crazy Mountains in Montana, by J. E. Wolff, from the author. Apart from Proceeding of Societies, Journals and Exchanges, there have not been quite so many donations from individuals as in former years.

William C. Rives, Jr., Librarian.

Newport, May 5th, 1887.

LIST OF LECTURES DELIVERED BEFORE THE SOCIETY, 1886-7.

1886.

June 3. Water Supply, by Capt. J. P. Cotton.

June 29. A Geological Ramble through the Tyrol, by Prof. T. N. Dale.

Aug. 6. The Origin of Life and its Early Developments, by Dr. W. Duncan McKim.

Sept. 3. Geological Development of the Pacific Slope, by Geo. F. Becker.

Oct. 28. Notes on the Shore Birds of Rhode Island, by Charles H. Lawton.

Oct. 28. The Extinction within Historic Times of Certain Wild Animals in a Corner of Europe, by A. O'D. Taylor.

Nov. 29. Light and the Organs of Vision in Man and the Lower Animals, by Charles D. Mueller.

1887.

Feb. 12—March 26. Course of seven Geological Lectures of an Educational Character, by Prof. T. N. Dale.

April 2—23. Course of four Lectures of an Educational Character on Cryptogamic Botany, by Prof. T. N. Dale.

LIST OF MEMBERS.

Agassiz, Prof. Alexander
Almon, Andrew B.
Baker, A. P.
Bell, George N.
Bliss, Richard
Bosworth, Miss R. T.
Brinley, Hon. Francis
Buffum, William
Calvert, Hon. G. H.
Carry, John J.
Chace, Miss E. B.
Child, Clarence
Clark, Rev. E. F.
Colgate, R.
Cotton, J. P.
Cottrell, Charles M.
Crawford, Bvt.Maj.Gen.S.W.,U.S.A.
Daniels, F. A.
Davis, Lucius D.
Day, Rev. John W.
Dockray, George M.
Dunn, Thomas
Edgar, Herman LeRoy
Elliot, Col. G. H., U. S. A.
Emerson, Rev. Forest F.
Engs, Jr., John S.
Fearing, Daniel B.
Ford, T. G.
Forsyth, Russell
French, A. T.
French, F. O.
Gilliat, Rev. C. G.
Greene, Dr. W. S.
Hammett, Jr., Chas. E.
Hammett, Miss E.
Hammett, F. M.
Heard, Dr. J. M.
Hunter, Miss Augusta A. V.
King, David
King, Miss Edith E.
King, LeRoy
Little, Lt. Wm. McCarty, U. S. A.
Magill, Rev. George J.
Mason, George C.
Mason, Jr., George C.
Mason, Dr. J. J.
Matthews, Capt. E. O., U. S. N.
McKim, Dr. Wm. D.
Mueller, C. D.
Ogden, Dr. John D.
Parker, Dr. Joseph B.
Parmenter, Amon
Pitman, Mrs. T. T.
Post, Miss E.
Powell, Dr. S. C.
Pumpelly, Mrs. R.
Rankin, Dr. Francis H.
Rhinelander, Jr., F. W.
Rhinelander, P. M.
Rhinelander, T. N.
Read, Gen. M.
Rives, Wm. Cabell
Rives, Jr., Dr. Wm. Cabell
Robinson, Dr. Beverly
Rogers, Prof. Fairman
Rogers, Mrs. Wm. B.
Sanborn, John P.
Seabury, Jr., T. M.
Selfridge, Capt. T. O., U. S. N.
Smith, Howard
Smith, Mrs. Howard
Southwick, J. M. K.
Squire, Dr. A. F.
Stevens, Henry C.
Storer, Dr. Horatio R.
Storer, Malcolm
Swan, Jr., J. M.
Swinburne, Geo. W.
Swinburne, H. H.
Taylor, Alexander O'D.
Thompson, Prof. Frank E.
Vernon, Jr., Geo. E.

King, Mrs. Mary A.
King, Miss Mary LeRoy
King, William Dehon
Lawton, Charles H.
Lawton, Jr., Wm. H.
Lewis, Jr., Walter
Wales, George W.
Waring, Jr., Col. Geo. E.
Wharton, Joseph
Wheeler, Dr. W. L.
White, Prof. J. F.
Whitehouse, Wm. F.

CORRESPONDING.

Arnold, Dr. E. S. F., Yonkers, N. Y.
Bailey, Prof. W. W., Providence, R. I.
Bliss, Richard A.
Bartlett, John, Cambridge, Mass.
Cerio, Dr. J., Capri, Italy.
Conklin, Prof. W. A., New York.
Dale, Prof. W. A., Newport.
Downs, Andrew, Halifax, N. S.
Gilpin, Dr. Bernard, Annapolis, N. S.
Gooch, Dr. F. A., Washington, D. C.
Lossing, Benson J., LL. D., New York.
Whitfield, E., Albany, N. Y.
Willis, Bailey, Washington, D. C.
Wilson, A. D., Washington, D. C.

HONORARY.

Baird, Prof. Spencer F., Washington, D. C.
Coues, Dr. Elliot, U. S. A., Washington, D. C.
Ferguson, Maj. T. B., U. S. Fish Com., Washington, D. C.
Sclater, Dr. Philip Lutley, F. R. S., London, England.

LIFE.

Astor, Mrs. W.
Bennett, James Gordon
Brown, Harold
Brown, J. Nicholas
King, George Gordon
Low, A. A.
Marquand, Henry G.
Powel, Col. John Hare
Pumpelly, Prof. Raphael
Rhinelander, F. W.
Wetmore, George Peabody

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